An Individual Information Management Method on a Distributed Geographic Information System

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Abstract

This paper proposes a method to manage individual information on large scale distributed geographic information systems. On such system, ordinary users usually cannot alter the contents of the server. The method proposed in this paper makes possible to alter the contents or add individual data onto such kinds of non-write-permitted dataset. We call the method as GDSF, 'geographic differential script file'. In this method, a client user makes a GDSF which contains the private information to be added onto the served data. Then, the client keeps the file on a local disk. After this, when the user uses the data, he applies the differential data sequence onto the down loaded data to restore the information. The GDSF is a collection of picture commands which tell pictures insertions, deletions, and modification operations. The GDSF also can contain the modification of the attribute information of geographic entities. The method also applicable to modify data on a ROM device, for example CD-ROM or DVD-ROM. This paper describes the method and experimental results.

1 Introduction

Geographic information systems (GIS) become popular these days including in the fields of prevention of disasters, facility management, environmental assessment and marketing. According this, the amount of data stored and processed on the system are getting larger. On the other hand, the usage of local area network (LAN) and internetwork progresses, especially the distributed systems based on the client/server model are used widely. We believe the move toward the distributed system becomes essential.

On a distributed system, general client users cannot alter the contents managed by a server. Only privileged user can change the contents. However, sometimes the client users also wants to record their private information on the database.

One method to keep the client individual informations is to down-load the necessary data from the server and to apply some alternation or addition on the down-loaded dataset. This method, however, is disk consuming, and to make difficult data management. For example, this method cause a situation data of some area is already down-loaded and apply modification and some other area must be down-loaded from the server. Furthermore, when the data on the server are updated, the user cannot use the updated data unless discard the modified data.

Another non-write-permitted data is the data recorded on a ROM device, for example CD-ROM and DVD-ROM. Actually, several geographic data are served on such media. On these media, the same situation occurs.

The method presented in this paper is applicable to such situations. In this method, local client keeps a file recording the modification of geographic information to the served data on the client disk. We call the file as 'geographic differential script file (GDSF)'. The file contains the modification as the sequence of the graphic operations. More concretely, the file records the sequence of the operation to make individual file from the down-loaded data. Insertion, deletion, and modification of the picture, and such of the attribute information are the basic operations.

2 General concept of GDSF

In the actual usage of the distributed GIS, there are several servers and clients on the LAN. Each server has their own purpose having the geographic data, for example facility management, road management, urban planning, etc. These purposes do not always meet the ones of the clients.

The client is served necessary data from a server through the LAN. The data, however, is managed for the special purpose of the server. Then, the client may not be completely satisfied by the data. Sometime, clients want to make some modification on the received data.

However, as mentioned before, the client does not permit to write back the modified data on the server, because the server manages the data upon a different purpose from the client. It is not good to modify the data to the form suitable for the client purpose. Also, from the view of the security and the consistency, it is not good to be altered the server data by a client. Then, the only way a client modifying the data is to be done the modification on the down-loaded data.

For the convenience of the next occasion to use the data, the client might save the data on their own disk. The method that the client keep the whole modified data is one of the practicable measures. By this method, the data transfer could be omitted on the next occasion. But, several versions of a data come to exist on the LAN. Then, some confusing might be occurred in this case.

Our proposed method is to keep only the difference between the original and the modified version on the client. Next occasion of using the data, the modified version of data is restored by the down-loaded data from the server and the difference data by the method mentioned below.

To deal with this problem, we adopt a differential script file to geographic data. The differential file consist of graphic and attribute editing commands. Hereafter, we call this file as 'geographic differential script file (GDSF)'. When a user of a client makes a modification on an original GIS data, the user makes a GDSF describing the different portion, then keeps the file on the client disk. How to use the GDSF is; first, get the original data from the server, then apply the geographic editing command using the stored GDSF.

The GDSF is applicable anytime to record the difference between the original data existing on a server and the expected data of a client user. The following is a typical example to use the GDSF. A client always use a geographic data on a server. In a case the manager of the server does not maintain the data to up-to-date, some difference between the data and the real world cause in some day. To correct the difference, the client makes a GDSF. In the GDSF, deletion, insertion, and modification of geographic objects are recorded. Under the circumstance, when the client receives a data from the server, the client applies the patch on the down-loaded data before using the data. Finally, the client user get the newest version. By this, the client can always use the modified (i.e. the newest version) data, and this patch gives no bad effect to the data on server. So, the users who want to keep using the old version of data, they can do it.

At the present, the GDSF is capable basically for the following three kinds of correction. More complicated correction can be available by the combination of the three commands.

addition addition of a new geographical object

deletion deletion of unnecessary object

modification modification of position, shape and attributes of object

Concretely, the system is implemented as follows.

1. making GDSF
   - **(i)** A client makes some modification on the down loaded data using a geographical editor.
   - **(ii)** The geographic editor generates a GDSF.
   - **(iii)** The client keeps the GDSF on its own local disk.
2. using GDSF
   - **(i)** The client down-loads a necessary data from a server.
   - **(ii)** Check whether the GDSF corresponding to the down-loaded data exist.
   - **(iii)** If so, carry out the patch on the down-loaded data using the GDSF.

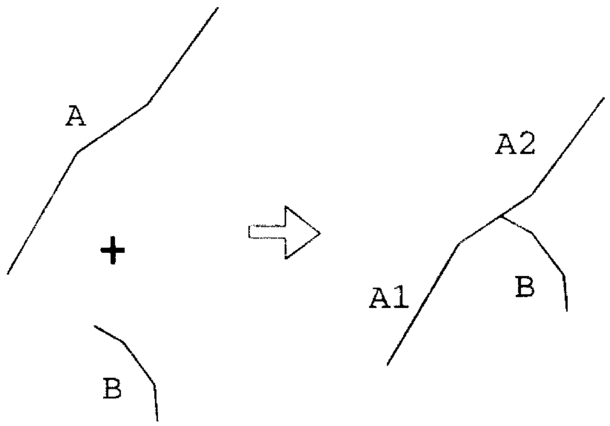

Figure 1: Line splitting operation

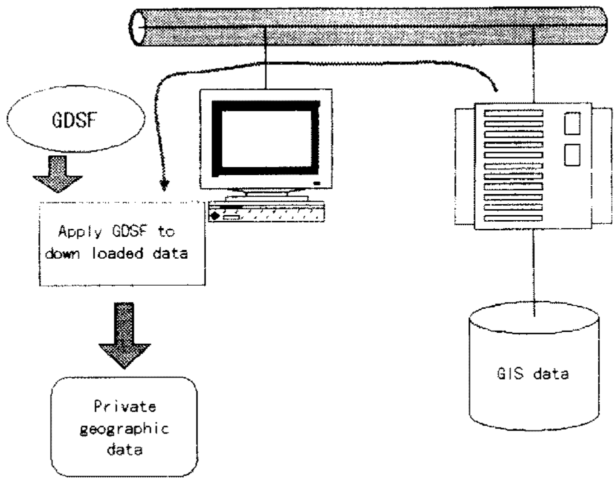

Figure 2: Concept of the patch-file

Fig.1 shows an example that line B is added in the form to connect to the line A. In this case, the next operations are carried out to make the GDSF.

1. Let the connecting point of line A and line B be C.
2. Split line A at C. Let the split two lines be A1 and A2.
3. Write the following operations to the GDSF.
   - Delete line A.
   - Add lines A1 and A2.
   - Add line B.

When to restore the change based on the down-loaded data, just apply the modification on the down-loaded data.

The above mentioned graphical operations are written on the GDSF. The time print is also included in the records of the GDSF. Then, we can recognize when the change was came into existence. We also can restore the map of a specific time, by using the time print information.

3 Picture command in GDSF

Geographic information consist of geometric information and attributes. The attributes are alphanumeric information, and they are the same handled by usual database system. The special point in geographic data is in the former information. Then the following is focused on geometric feature.

Modification of geographic data in GIS is done by a combination of picture addition, deletion and alternation of the shape and the position of geographic entities. More concretely, it is done by giving indication to graphic editor using mouse or digitizer. We name the command to specify the position and the shape of a entity picture command. In the proposed method, the alteration of the down loaded data is done by a sequence of the picture commands.

The basic commands using in the alteration is as follows;

- addition of geographic entity
- deletion of geographic entity
- modification (shape and position) of geographic entity
- alteration of attribute

The picture command is composed by the following elements.

- mesh code of the area
- layer code
- command code
- command options (position and shape)
- time occurred the event

Japanese industrial standard (JIS) define the mesh code which indicate the position among the rectangularly divided areas. The mesh code defined hierarchically from the first mesh to the third mesh. The first mesh corresponds about 80km rectangle area. For a first mesh area, four digits code are assigned, for example '5339'. A divided area into 8 x 8, horizontally and vertically is called as the second mesh, which corresponds about 10km square rectangle. For a second mesh area, two more digits follows to the first mesh code, indicating the position among divided 64 areas. An example of a second mesh code is '533941'. The third mesh is assigned one of the divided into 10 x 10 area, and the third mesh code is two more longer code than the second mesh code. Our system adopted this mesh code for data management unit. The first item above shows this mesh code.

Map information consists of data belong several categories. For example river, road, rail way, building, and so on. Each category is called a layer. For example road forms a layer, and river also forms a layer. A picture command is necessary to show what layer is concerning of alteration. The second item in the above show the layer code.

The third item, command code, shows a kind of operation to be done. For example to insert a node, to delete a road, etc. Some picture commands need to show X,Y coordinate to show position and the shape of the picture. The fourth item, command option, is for this purpose. For example to insert a polyline object, the vertices number and the X, Y coordinates of the vertices are given by the command option.

4 Implementation

We implemented the system described in this paper on a SUN workstation by C++ language. The data we used in this experiment are several kinds of digital maps issued by the Japan Geographic Survey.

Fig.3 shows an example of display of the system. In this example, an area about 80km square is displayed, which corresponds one first-mesh area defined by JIS (Japan Industrial Standard). Fig.4 shows magnified of a certain area in Fig.3.

Fig.zu:rei3 shows a result applying differential script file operations to Fig.zu:rei2. In this figure, some roads are added to and some road deleted from the data in Fig.zu:rei2. The differential file applied in this example is show below.

```
MT 5340
LY ROAD
I 0 3755 4682
I 0 3848 4605
I 0 4046 4347
I 0 3762 4231
I 0 3798 4015
I R 4 3755 4682 3775 4628 3798 4602 \
      3848 4605
I R 5 3848 4605 3923 4566 3983 4523 \
      4016 4447 4046 4347
I R 5 3762 4231 3702 4167 3683 4094 \
      3732 4061 3798 4015
MF 5340
```

The first command corresponds to make node on the point specified by the operands. The second, the fourth, and the fifth commands also order to make nodes on the specified position. The difference from the first command is the latter three commands make nodes on existing road lines. The third and sixth command make links between two existing nodes (i.e. crossing point). The rest three commands are ordering to delete road segments.

Fig.6 shows minimum path on the road between two specified points. The minimum path was calculated by A* algorithm. As shown in this example, some roads defined in the GDSF are handled equally with the other roads already existing in the database when some geographic operations are applied.

5 Conclusion

This paper has discussed a method to keep individual information on a large scale geographic information system environment. To maintain the change of the geographic information on servers and individual information, we have proposed a method using the GDSF. We are now implementing the system on a SUN-SPARC workstation, by C++ language.

For the GDSF, we think we have to improve the following points. When the geographical data on a server modified, some inconsistency occur between the GDSF and the modified data on the server. Currently, the GDSF contains only time print of the modified time, however, the time when the actual change occur in the real world also necessary

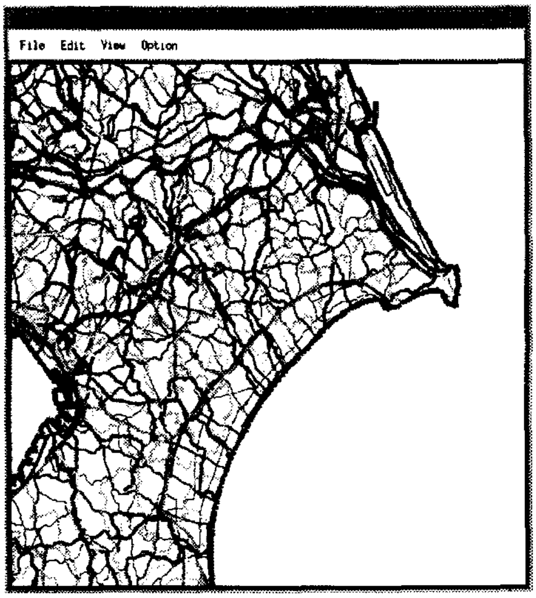

Figure 3: An example of display

for the time management. Putting the time information on the GDSF, to compare the time and the modified time on the server database, and discard the older data according to this time point, we cope the problem. The GDSF, at present, can handle only one history. We also think plural number of history management become necessary in a future.

The other topics for future work about this system are as follows:

- The system works only on UNIX operating system, at present. We are thinking to make system applicable on several kinds of operating systems including WINDOWS.
- To develop the system work in plural scaled maps exist.
- To be substantial the functions of patch-file.

Acknowledgment

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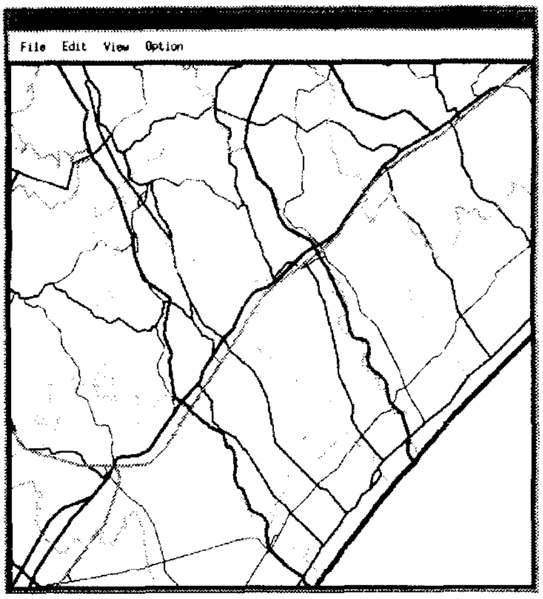


Figure 4: Before applying patch

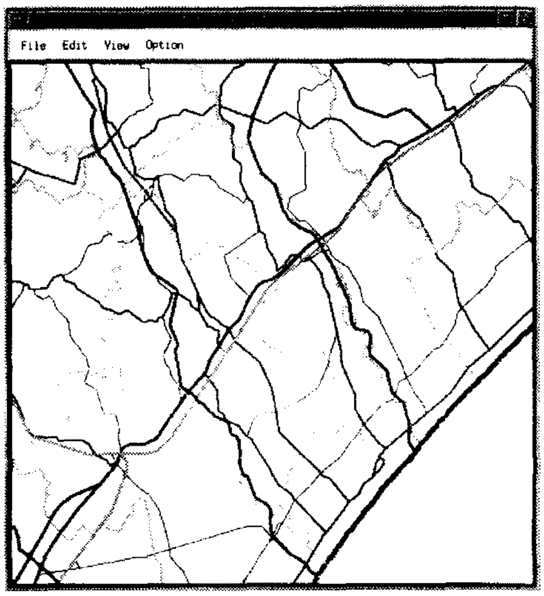
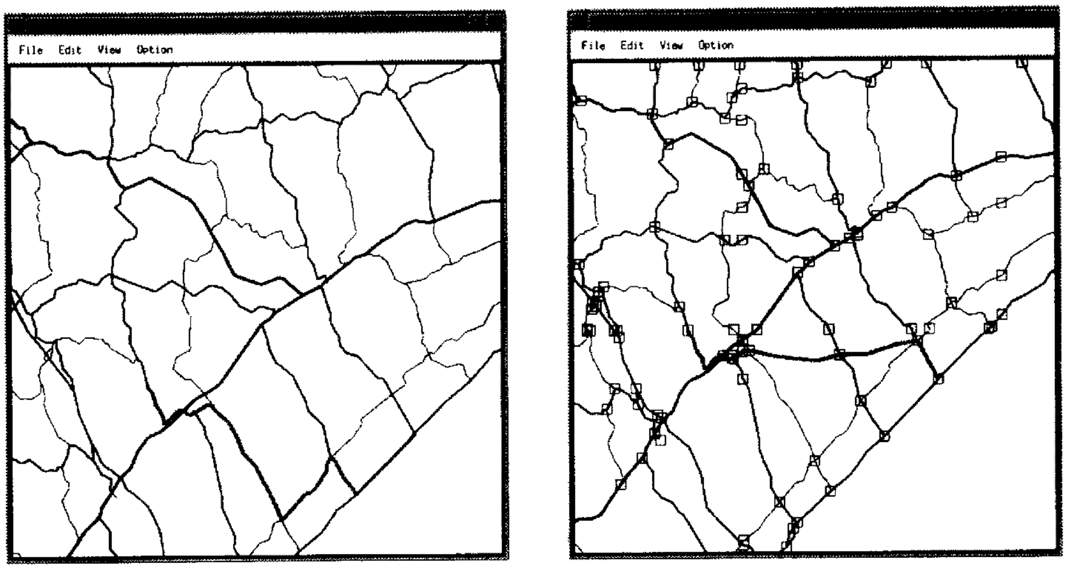


Figure 5: After applying patch



(a) (b)

Figure 6: Shortest path change by applying patch

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